REMARKS

Claims 1-6 are all the claims pending in the application. This Amendment adds claims 4-6, and addresses each point of objection and rejection raised by the Examiner. Favorable reconsideration is respectfully requested.

Applicants thank the Examiner for acknowledging the claim for foreign priority, noting that the priority documents have been received, and initialing the Information Disclosure Statements filed May 20, 1999, November 7, 2000, and January 4, 2001.

As a preliminary matter, the Examiner objects that the reference numbers in Figs. 2 and 3 are not identified in the specification. Applicants amend the discussion of Figs. 2 and 3 in the specification to identify the various layers.

Additionally, the Draftsperson objects to Figures 16 and 17 for line quality. Applicants will prepare and file new figures.

Claim 1-3 are rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent 4,728,628 to Fiddyment *et al.* (herein "Fiddyment") in view of "High-Power High-Efficiency 0.98μm Wavelength InGaAs-(In)GaAs(P)-InGaP Broadened Waveguide Lasers Grown by Gas-Source Molecular Beam Epitaxy," IEEE Journal of Quantum Electronics, Vol. 33, No. 12, pages 2266-2276, by Gokhale *et al.*[1] ("herein Gokhale") and "A study of structures with Al-free QWs in AlGaAs waveguides for laser diodes emitting at 800 nm," by Erbert *et al.* (herein "Erbert"). The Examiner asserts that Fiddyment teaches all of the limitations of claim 1-3, with the exception of (1) forming the upper and lower cladding layers from AlGaAs and (2) an optical waveguide layer equal or greater than 0.25μm in thickness.

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[1] Referred to as "Milind" in the Office Action, which Applicants interpret to refer to author "Milind R. Gokhale".

Regarding (1), the Examiner asserts that "it is well known in the art of lasers that a lower cladding is used to further absorb unwanted emissions of the QW region and further confine the laser guided within the waveguide structure." Therefore, the Examiner asserts, it would have been obvious to choose AlGaAs for the cladding layers "to conform with conventional practice."

Regarding (2), the Examiner asserts that the teachings of Gokhale render the 0.25μm limitation obvious, and that someone would be motivated to combine the teachings of Gokhale with Fiddyment to achieve a desired performance.

The Examiner cites Erbert for using an aluminum-free active region to reduce degradation of the laser.

Applicants respectfully traverse the grounds of the § 103(a) rejections for the reasons set forth below.

The present invention is a semiconductor quantum-well laser having an active region and optical waveguide layers formed from $In_xGa_{1-x}As_yP_{1-y}$, having an upper and lower cladding layer formed of AlGaAs. At least one of the optical waveguide layers is not smaller than 0.25μm in thickness.

By utilizing an optical waveguide layer having a thickness of not less than 0.25μm, internal losses are reduced by reducing the residual loss in the active layer, as discussed in the present specification from page 19, line 24 to page 22, line 11. Moreover, when the thickness of the optical waveguide layer is not smaller than 0.25μm, deterioration in crystallization is prevented. *See* page 9, lines 11-14. This deterioration in crystallization is caused by non-emission recombination of carriers. *See* page 5, lines 5-11.

The materials forming the device, and manufacturing method utilized in producing the device, allows etching to be stopped at the interface of the upper optical waveguide layer and upper cladding layer, without the use of an etching stop layer. *See* page 9, lines 2-6.

Fiddyment discloses a device formed of quaternary materials indium gallium arsenide phosphide. *See* Fiddyment column 1, lines 7-10, 35-36, 41-42; column 5, lines 35-45. The thickness of each of the lower (3) and upper (5) optical waveguide layers is 0.2μm in thickness. *See* Fiddyment column 5, lines 35-36. A heavily n^+ doped InP substrate (1) is used as a lower cladding layer. The upper cladding layer is a p-type InP layer (7"). *See* Fiddyment column 7, lines 21-30.

A part of the upper cladding layer (*i.e.,* layer 7 in Fig. 4) is selectively removed up to the interface of the upper cladding layer (7") and the upper optical waveguide layer (5), forming channels (16 and 17). *See* Fiddyment column 6, lines 50-57. The upper cladding layer (7") forms the ridge of the laser, and provides current confinement. *See* Fiddyment column 3, lines 44-53; column 6, lines 62-64. Fiddyment teaches "Preferably, there is in the initial semiconductor structure a boundary between materials of different etchability corresponding to the boundary between the base semiconductor portion and the elevated semiconductor portion." Fiddyment column 3, lines 7-12. Second and third elevated portions (7 and 7') facilitate mounting of the laser to a contact stud. *See* Fiddyment column 2, lines 53-62; column 3, lines 54-63; column 7, lines 17-27.

Fiddyment indicates that InP and InGaAsP are often used in lasers operating from 1.3 to 1.6μm, whereas "semiconductor lasers comprising regions of gallium aluminum arsenide and gallium arsenide are also used for communications purposes. These operate near 0.9μm." *See* Fiddyment column 1, lines 28-46. No further discussion of aluminum-containing structures is offered.

Gokhale fabricates a device from quaternary materials. Quantum wells are InGaAs, using InGaAsP or GaAs for the upper and lower optical waveguide layers, and InGaP cladding layers. *See* Gokhale page 2267, column 1. Gokhale teaches to increase the thickness of the optical waveguide layers to improve laser performance. *See* Gokhale page 2266, column 2.

Applicants submit that substituting AlGaAs for the InP cladding layer of Fiddyment "to absorb unwanted emissions of the QW region and further confine the laser guided within the waveguide structure" is not suggested by the applied art. Specifically, Gokhale teaches to reduce the overlap of the optical mode with the cladding layer, to reduce free-carrier absorption in the cladding layer, and to decrease confinement, by widening the optical waveguide layers. *See* Gokhale page 226, column 2. Waveguide broadening decreases the confinement factors of the laser mode in the cladding layers, thereby reducing losses. *See* Gokhale page 2267, column 2 to 2268, column 1, and Fig. 2(a) and 2(b). Fiddyment forms the device utilizing an etching method that relies on the etching of the InP layer 7, "without appreciably attacking quaternary layer 5". *See* Fiddyment column 6, lines 50-57. If, as the Examiner suggests, AlGaAs is substitute for InP, it is uncertain from the teachings of the applied references as to whether the etching method and/or structure of Fiddyment would have to be further modified. Any such uncertainties should be construed against the Examiner. Moreover, in view of the teachings of Gokhale regarding the widening of the optical waveguide layers, which the Examiner relies upon to support widening the optical waveguide layers of Fiddyment, there would be no motivation to substitute AlGaAs as the cladding layers to absorb unwanted emissions.

Further, unlike Gokhale where the thickness of the optical waveguide region reduces free-carrier absorption, the thickness of the optical waveguide layer of the present invention is not less than 0.25μm to reduce the internal loss by reducing the residual loss in the active layer.

Applicants submit that since such considerations depend upon the materials which are utilized as the layers, asserting motivation based on this difference suggests application of hindsight.

Applicants add new dependent claims 4-6, which are not obvious for at least the reasons claims 1-3 are not obvious. No new matter is introduced in the new claims.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

Applicants hereby petition for any extension of time which may be required to maintain the pendency of this case, and any required fee, except for the Issue Fee, for such extension is to be charged to Deposit Account No. 19-4880.

Respectfully submitted,

David A. Klein

Susan P. Pan
Registration No. 41,239
David A. Klein
Registration No. 46,835

SUGHRUE, MION, ZINN,
MACPEAK & SEAS, PLLC
2100 Pennsylvania Avenue, N.W.
Washington, D.C. 20037-3213
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

Date: May 14, 2001

APPENDIX

Version With Markings To Show Changes Made

IN THE SPECIFICATION:

The specification is changed as follows:

Page 5, replace the second full paragraph (lines 12-18) as follows:

Accordingly, a method in which etching is carried out up to a portion immediately above the active layer has been generally employed. Figure 2 shows a ridge waveguide type laser having an n-side electrode 20, an n-GaAs substrate 11, an n-GaAs buffer layer 12, an n-AlGaAs cladding layer 13, an undoped SCH active layer 14, a p-AlGaAs cladding layer 16, a p-GaAs capping layer 17, a SiO_2 insulating film 18, and a p-side electrode 19. In this case, [as in a ridge waveguide type laser shown in Figure 2,] etching is carried out so that the upper cladding layer 16 is left in a small thickness 15 (about 0.1 to 0.3μm) by controlling the etching time.

Page 6, replace the third full paragraph (lines 19-25) as follows:

However such etching time control is disadvantageous in the reproducibility deteriorates due to fluctuation in etching conditions and thickness of the cladding layer from wafer to wafer. In order to overcome this problem, there has been proposed a structure in which an etching stop layer 26 as shown in Figure 3. The structure in Figure 3 has an n-side electrode 31, an n-GaAs substrate 21, an n-GaAs buffer layer 22, an n-AlGaAs cladding layer 23, an undoped SCH active layer 24, a p-AlGaAs cladding layer 25, a p-InGaP etching stop layer 26, a p-AlGaAs cladding layer 25, a p-GaAs capping layer 28, a SiO_2 insulating film 29, and a p-side electrode 30. See United States Patent No. 4,567,060 (reference 4).

Pages 5-6, replace the paragraph bridging these pages (p. 5, line 26 to p. 6, line 6) as follows:

For example, in the case where an AlGaAs cladding layer 23/25 and an InGaAsP active region 24 are combined, by inserting an InGaP etching stop layer 26 (about 1 to 5nm in thickness), which is lattice-matched with the GaAs substrate 21, into the upper cladding layer 27 as shown in Figure 3, it becomes feasible to stop etching of the AlGaAs 27 at the InGaP etching stop layer 26 in various etching methods.

Page 13, second full paragraph (lines 7-9) as follows:

Figure 13 is a view showing a comparison of measured relation between the number of quantum wells and the [slop] slope efficiency and theoretical relation of the same,

IN THE CLAIMS:

Claims 4-6 are added as new claims.